

Jet Fuels of the Future...

The Future is Now!



bp

DESC Worldwide Energy Conference 2004
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Scope

- > **Where are we now?**
- > **What is a “clean” fuel?**
- > **Options for clean jet fuels?**
- > **What are the issues limiting development of future jet fuels?**

Where Are We Now?

- > **Kerosene-based fuels...for the next 50+ years?**
 - > **Mostly crude oil derived**
 - > **Small proportion “synthetic” (*ie* non-crude oil derived)**
- > **Most tightly specified fuel produced in the refinery**
 - > **Defined by safety / operational / cost requirements**
 - > **Regionally different specifications**
 - > **Limited range of approved additives**
- > **On the fringes of environmental legislation ?**
 - > **IPCC Special Report “Aviation and the Global Atmosphere”, 1999**
 - > **Reductions in spirit of Kyoto Agreement**
- > **Self Regulation?**



Performance Properties Controlled by the Jet Fuel Specification:

Composition <ul style="list-style-type: none">• Acidity• Aromatics• Sulfur	Combustion <ul style="list-style-type: none">• Energy content• Smoke point• Naphthalenes
Volatility <ul style="list-style-type: none">• Distillation• Flash point• Density	Contaminants <ul style="list-style-type: none">• Existent gum• MSEP• Water reaction
Fluidity <ul style="list-style-type: none">• Freezing point• Viscosity	Stability <ul style="list-style-type: none">• Thermal stability
Additives <ul style="list-style-type: none">• AO, MDA, FSII, CI/LI, SDA, +100	Corrosion <ul style="list-style-type: none">• Copper corrosion

IPCC Special Report on “Aviation and the Global Atmosphere” (1999): Fuel-related Conclusions

- > Aviation contributes 12% to world transport CO₂ emissions (equivalent to approx. 2% of fossil fuel global CO₂ emissions)
- > “No practical alternatives to kerosene -based fuels for commercial jet aircraft for the next several decades”
- > Reducing sulfur content will reduce SO_x emissions and sulfate particle formation (implicated in contrail and cirrus cloud formation)
- > Overall environmental impacts and environmental sustainability of hydrogen or any other alternative fuels have not been determined



Self Regulation

- > **Specification authorities act ahead of anticipated changes to fuel properties imposed by regulatory agencies**
 - > **Sulfur is the target in all fuel specifications**
 - > **US Military proposal - 2000 ppm max**
 - > **Defence Standard proposal - 2000 ppm max**
 - > **IATA proposal - 2500 ppm max**
 - > **ASTM proposal - ??**
- > **Will reducing S to these levels make any difference?**

What are *CLEAN FUELS*?

- > Clean fuels produce “less” pollution when burned
- > The pollutants of concern include SO_x , NO_x , CO, UHC, particulates and others that form post-combustion
- > Low sulfur fuels produce less SO_x , therefore less particulate emissions and contrails/cirrus clouds??
- > *Unfortunately we haven't figured out how to*
use catalytic converters and particle traps
on airplanes!
NO, UHC, CO are not directly related to sulfur content



Future Jet Fuels...Will they be “Clean”?

- > Jet fuel is not *DIRTY*, but...
- > Sulfur levels typically much higher than ground fuels
- > Reducing sulfur levels < 500 ppm will reduce / remove other bad actors - aromatics, nitrogen & oxygen containing species, trace metals
- > A combination of changes to fuel properties along with improvements in combustion technology are needed to achieve lower emissions
- > Replace “old” technology with “new”

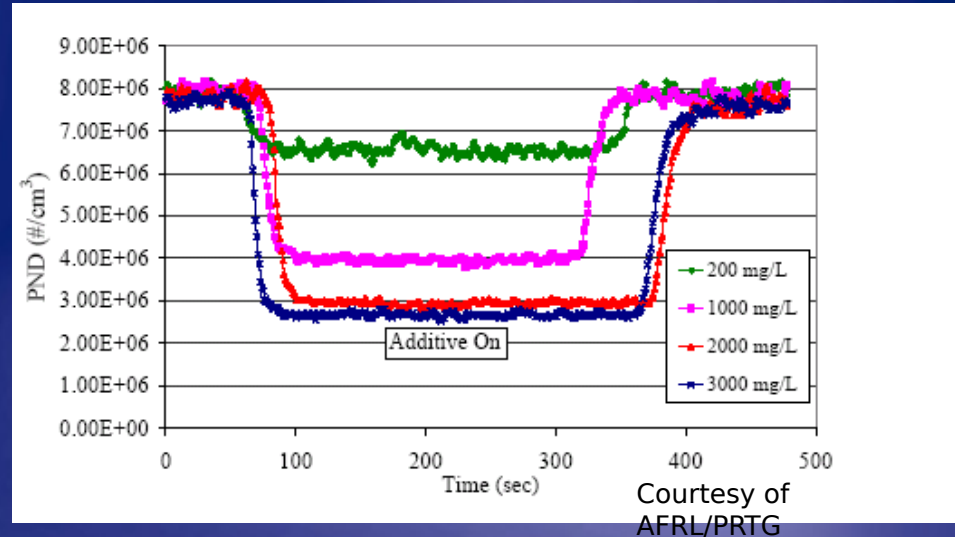


Will the new reduced sulfur regulations for diesel and gasoline affect jet fuel sulfur

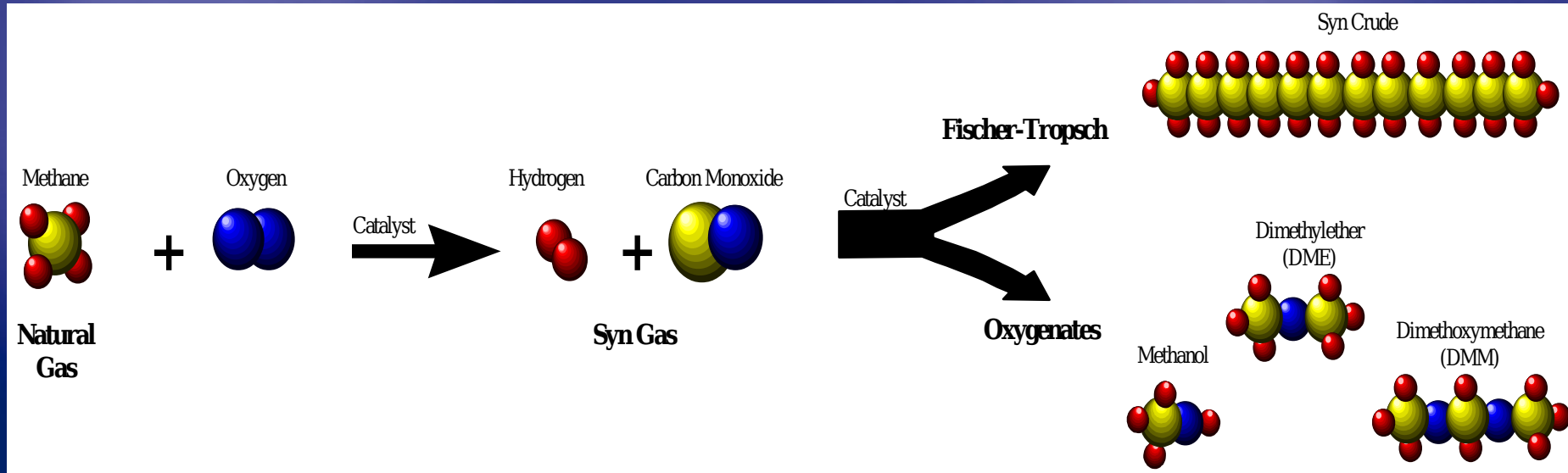


Options for Cleaner Jet Fuels

- > Significantly reduce max sulfur content
- > Reduce max aromatic content
- > Eliminate the higher boiling components
- > Additives →
- > Synthetic fuels



GTL - The Future of Clean Fuels?



- > Most oil majors are involved in GTL technology
- > Deepwater GTL projects may be feasible
- > Syntroleum GTL barge for DoD
- > High natural gas prices spark renewed interest in coal/coke gasification

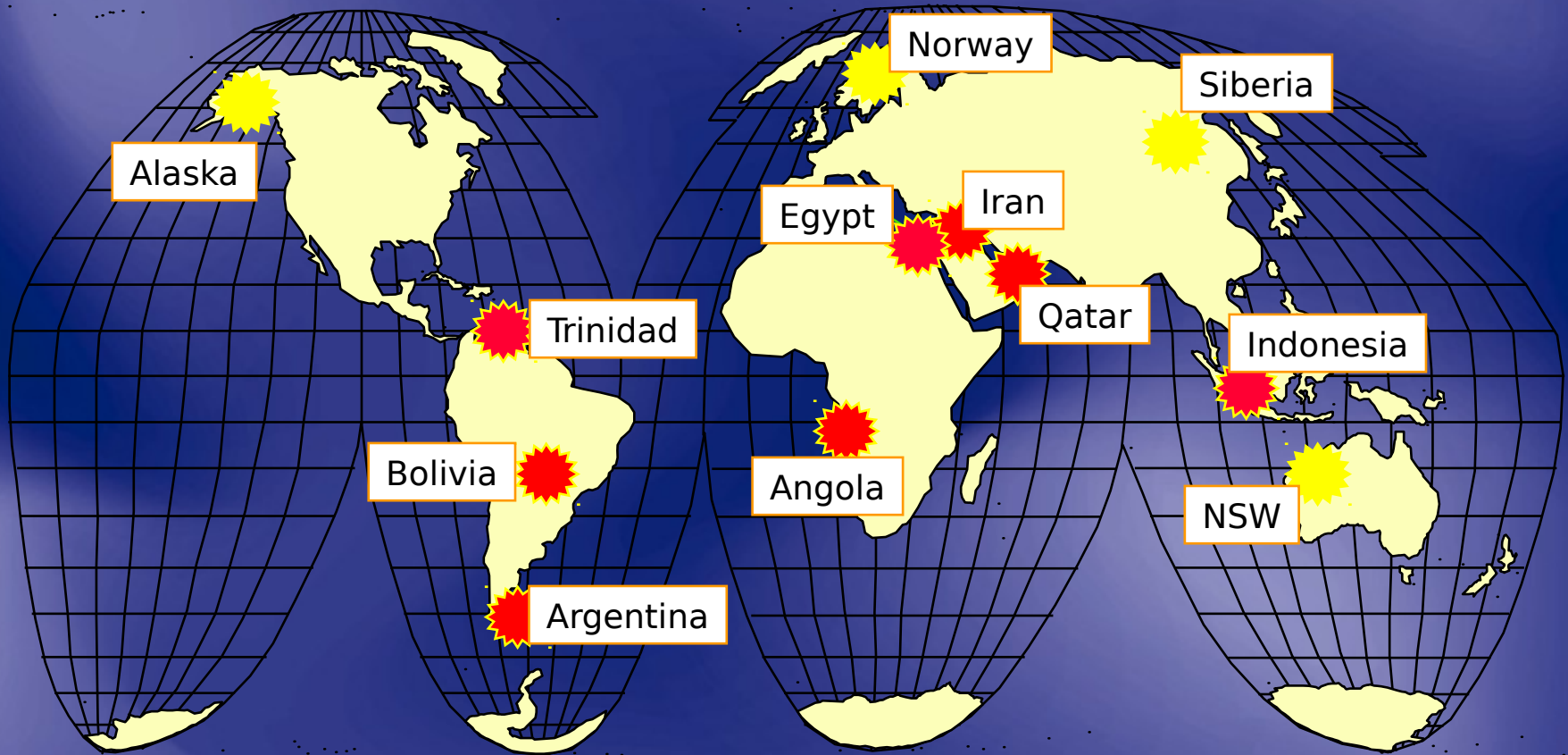
Primary Energy Resources: Which Gas Can Be Brought to Market?



Priority Opportunities



Second Tier Opportunities



Barriers to Overcome: Evolution not Revolution

- > **Safety**
- > **Commercial**
- > **Technical**
- > **Inertial / tradition / logistical**
 - > **Legacy aircraft / engines**
 - > **Conflicts with other refinery products and processes**
 - > **Existing distribution systems - lack of incentive if changes not mandated**
- > **Specifications / approval processes**

Change is slow, but inevitable !!

- > **Regulatory changes to gasoline and diesel fuel specifications influencing refinery processing / economics**
- > **Possible regulatory changes to jet fuels**
 - > **Linked to air quality / emissions legislation**
 - > **“cleaner” fuels**
 - > **improved efficiency**
 - > **Specification harmonization**
- > **Customer demands**
 - > **Advanced equipment requirements**
 - > **Improved fuel properties**
- > **Continued developments in new technology areas**
 - > **Fuel production / processing**
 - > **Additives**



Towards Future Jet Fuels

- > **Continued use of kerosene-type hydrocarbon fuels in foreseeable future**
 - > **Likely to be sourced mainly from crude oil and natural gas**
 - > **New technology processing options likely to become available**
 - > **Increasing use of additives**
- > **Developments leading to improved properties increasingly demanded by engine manufacturers, militaries and airlines:**
 - > **Higher thermal stability**
 - > **Lower freezing point (Jet A-1)**
 - > **Higher specific energy density**
 - > **“Cleaner” - lower emissions**
 - > **Reduced operating costs; extend maintenance intervals to 20,000+ hours**
- > **Different production technologies and fuel sources allowing fit-for-purpose fuel requirements to be “dialled-up”**



Questions...And THANK YOU!

